A BRIEF REVIEW OF *CICINDELA FULGIDA* WITH DESCRIPTIONS OF THREE NEW SUBSPECIES FROM NEW MEXICO (COLEOPTERA: CICINDELIDAE)[1]

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ABSTRACT: The proposed new *Cicindela fulgida* subspecies from saline habitats of New Mexico include three populations that have minimal gene flow because of hydrographic isolation. This isolation has promoted sufficient genetic change and expression within the three separate populations to produce geographically recognizeable subspecies. Two populations reside on saline soils along marshes and river beds; the third site is a natural sink, a remnant of the most recent glacial retreat. These three populations described below are *C. fulgida williamlarsi* from San Ysidro, *C. fulgida winonae* from Grants, and *C. fulgida rumppi* from Willard, New Mexico.

Rumpp (1961) described three new species of *Cicindela* from the southwestern United States, along with notes on prehistoric and present physiography, migration, isolation, and evolution. He listed a total of 12 species and subspecies of *Cicindela* from the Estancia Valley of New Mexico (including the new taxa), and concluded, in part (p.172), "*C. fulgida* is superficially different from northern New Mexico and midwest populations by the broadening of the maculation so that the lunules and bands are confluent as in *C. parowana platti* of the Death Valley System of California." The following year (summer of 1962) I collected *C. fulgida* at the Estancia site and immediately became interested in the populations within New Mexico.

Taxonomic considerations. *C. fulgida* was described by Say (1823) from "near the mountains of the Platte and Arkansas Rivers." Ron Huber informs me (pers. comm.) that the expedition (on which Thomas Say was the naturalist) proceeded from the Platte River to the Arkansas River by way of Fountain Creek in eastern Colorado. Huber thinks the type locality can thus be fixed along that route and he is currently working on the problem.

Almost exactly one century later, Calder (1922a) named the Westbourne, Manitoba population as *C. fulgida elegans*, but then found the name preoccupied and replaced it with *C. f. westbournei* (1922b). That same year, Calder (1922a) also named the enigmatic Lincoln, Nebraska population as *C. fulgida subnitens*, based upon the black form occurring there. Finally, W. Horn (1938) named the broadly maculated population

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from Lake Como, Wyoming as *C. fulgida pseudowillistoni.*

The most recent revision of the group, by Willis (1967), recognizes only the nominate race (no attempt was made to fix the type-locality) and *C. fulgida westbournei* as valid subspecies, based upon slight differences in the apex of the aedeagus, and differences in seasonal color change.

Norman Rumpp, using innovative techniques which he has perfected in recent years, was kind enough to subject several of the *C. fulgida* population samples to measurement of the alpha angle of the descending portion of the middle band (Fig. 1A).

These measurements clearly indicate that *C. fulgida* has a primary separation into eastern (middle band nearly right-angled) and western (middle band obtusely angled towards the elytral suture) components. These can then be further separated into smaller, localized subcomponents. A brief discussion is in order.

The eastern component consists of the nominate race and *C. f. westbournei.* I include under the nominate race, for the present, the

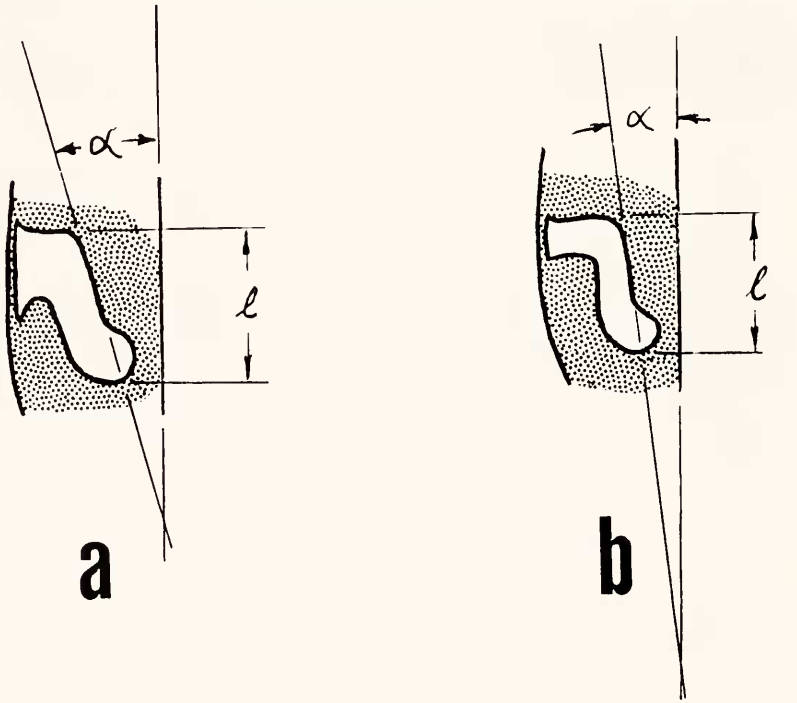


Fig. 1A. Descending angle and length of the middle band. a. depicts the middle band of the western *C. fulgida,* those at edge of, or within the bounds of the Rocky Mtns. (western component). b. depicts the middle band of the Great Plains *C. fulgida* (eastern component). Courtesy of N.L. Rumpp.

enigmatic *C. f. subnitens*. Willis (1967) dismissed *subnitens* as simply a color variant of the nominate race, which it may be. However, if the Lincoln, Nebraska area proves to be a refugium for relict forms, *subnitens* may defy conventional taxonomic analysis and require cytologic and/or genetic studies (obviously beyond the scope of this paper) to clarify its "true" status. Because Willis (1967) has given detailed analysis of the nominate *fulgida* and the subspecies *westbournei*, I see no need to elaborate further on the characters he used. However, for purposes of comparison, several samples of both races have been examined with respect to the middle band and apical lunule. The Kansas and Manitoba populations (eastern component) are typified (Figure 1Ab) by the mid-band beginning at the margin, moving directly towards the suture, extending posteriorly at mid-elytron, descending approximately parallel to the suture, then the terminal knob reaches toward the suture where it ends. The mid-band is strongly rightangular. The apical lunule also typifies the eastern population: beginning at the suture, narrowing laterally, and ending in a non-dilated terminus.

The western component is of greater significance to the scope of this paper. The primary characteristic is the alpha angle of the middle band, as shown in Fig. 1Aa. Noticeable differences also exist between the various subcomponents, and examination of these will be the major thrust of this paper. Only one of these subcomponents has been formally named as of this writing: *C. fulgida pseudowillistoni* W. Horn (1938), from southern Wyoming. Willis (1967) suggested that the sporadic occurrence of broadly maculated individuals in various western populations relegated the name *pseudowillistoni* to synonymy as merely a polytope. Perhaps he might have interpreted this differently had longer series been available to him from a greater number of western localities (particularly the three under study here). Another subcomponent, from southcentral Colorado (in the San Luis Valley) is currently under study by the Reverend Bernard Rotger. The three subcomponents from New Mexico are examined in detail in the following pages.

METHODS AND MATERIALS

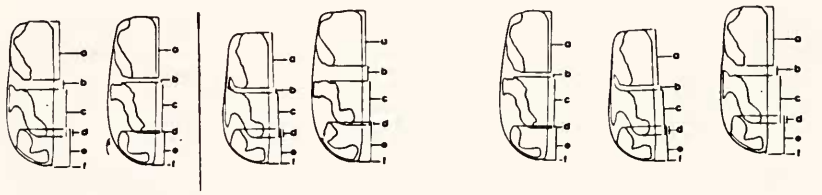
Diagnostic characters useful at the species level, but of little value in New Mexico subspecies determination, include anatomy and maculations of sexually dimorphic mandibles; labrum imperfectly tridentate; setal placement on antennal segments one and two; head hairy (see Wallis, 1961:51, Fig. 1), and male genitalia, determined by Rumpp (unpublished study, 1979) to be "exactly alike," although Willis (1967) illustrates variations in the apex of the aedeagus.

Characters used to separate the three new subspecies from New Mexico and to help segregate them from the Kansas and Nebraska samples (Tables 1 & 2) include length, width, and configuration of elytral maculations (Fig. 1 B) and their relative length when measured as a percent of the suture length (Tables 1 & 2); the length of gaps or spaces between maculations, and the length of two overlapping maculations represented as a percentage of the elytral suture length; the scutellum; and body coloration.

Methods used for measuring elytral maculations as a percent of the suture length are as follows: elytral margins are levelled laterally and longitudinally, in order to avoid distortion when viewing elytral macula-

Table 1. A COMPARISON OF TWO POPULATIONS BY SEX, OF MACULATION LENGTH, GAP, AND OVERLAP

Numbers express mean percent of elytral length at suture
● = longer (a -- e) measurement per character of two populations
▶ = longest length, ▷ = shortest length of all four populations. See text.



	San Ysidro	Grants	Willard	Mid West	Grants	Willard	San Ysidro
♂ a.	40.776	40.708	40.650	38.188 ◁	40.708	40.650	40.776
♂ b.	04.510	04 273 ▷	00.917	06.814 ◀	04.273	00.917	04.510
♂ c.	33.569	33.862 ▶	38.140	30.632 ◁	33.862	38.140	33.569
♂ d.	(04.642)	(04.159) ▶	(06.460)	(00.751) ◁	(04.159)	(06.460)	(04.642)
♂ e.	25.787	25.316 ▶	26.753	25.117 ◁	25.316	26.753	25.787
♂ f.	100.000	100.000	100.000	100.000	100.000	100.000	100.000
♀ a.	39.405	39.899 ▶	40.718	37.782 ◁	39.899	40.718	39.405
♀ b.	05.005	05.718 ▷	01.943	07.341 ◀	05.718	01.943	05.005
♀ c.	34.336	33.450 ▶	37.247	29.902 ◁	33.450	37.247	34.336
♀ d.	(03.542)	(04.451) ▶	(06.499)	(00.397) ◁	(04.451)	(06.499)	(03.542)
♀ e. ▷	24.796	25.384 ▶	26.591	25.372	25.384	26.591	24.796
♀ f.	100.000	100.000	100.000	100.000	100.000	100.000	100.000
♂♀ a.	40.088	40.282 ▶	40.683	38.002 ◁	40.282	40.683	40.088
♂♀ b.	04.757	05.032 ▷	01.431	07.056 ◀	05.032	01.431	04.757
♂♀ c.	33.955	33.645 ▶	37.752	30.296 ◁	33.645	37.752	33.955
♂♀ d.	(04.089)	(04.310) ▶	(06.539)	(00.589) ◁	(04.310)	(06.539)	(04.089)
♂♀ e.	25.289	25.351 ▶	26.673	25.235 ◁	25.351	26.673	25.289
♂♀ f.	100.000	100.000	100.000	100.000	100.000	100.000	100.000

Table 1. Any two *C. fulgida* populations of substantial numbers may be clearly separated by plotting the longest a-f measurement, by males, females, and combined sexes, where elytral length equals 100% at suture.

tions. Using a stereo microscope with an ocular micrometer, the actual elytral length is adjusted to fit 100 ocular units. The advantage of this method is the uniformity of measurements which allows any two or more populations to be compared to each other, as if all were the same length.

Table 2. ELYTRAL MEASURING POINTS (1-5), USED TO MEASURE LENGTH OF MACULATIONS, GAP, AND OVERLAP (a-e)

		San Ysidro			Grants			Willard			Midwest	
	Mean	Mean	%	Mean	Mean	%	Mean	Mean	%	Mean	Mean	%
♂	a	20.697	40.776	a	21.457	40.708	a	18.884	40.650	a	18.494	38.188
	1 20.697			1 21.457			1 18.884			1 18.494		
	b	02.289	04.510	b	02.252	04.273	b	00.426	00.917	b	03.300	06.814
	2 22.986			2 23.709			2 19.310			2 21.794		
	c	17.039	33.569	c	17.848	33.862	c	17.718	38.140	c	14.835	30.632
	3 40.025			3 41.557			3 37.028			3 36.629		
	d	(02.356)	(04.642)	d	(02.192)	(04.159)	d	(03.001)	(06.460)	d	(00.364)	(00.751)
	4 37.669			4 39.365			4 34.027			4 36.265		
	e	13.089	25.787	e	13.344	25.316	e	12.428	26.753	e	12.164	25.117
	5 50.758			5 52.709			5 46.455			5 48.429		
♀	a	20.125	39.405	a	21.408	39.899	a	19.698	40.718	a	19.007	37.782
	1 20.125			1 21.408			1 19.698			1 19.007		
	b	02.556	05.005	b	03.068	05.718	b	00.940	01.943	b	03.693	07.341
	2 22.681			2 24.476			2 20.638			2 22.700		
	c	17.536	34.336	c	17.948	33.450	c	18.019	37.247	c	15.043	29.902
	3 40.217			3 42.424			3 38.657			3 37.743		
	d	(01.809)	(03.542)	d	(02.388)	(04.451)	d	(03.144)	(06.499)	d	(00.200)	(00.397)
	4 38.408			4 40.036			4 35.513			4 37.543		
	e	12.664	24.796	e	13.620	25.384	e	12.864	26.591	e	12.764	25.372
	5 51.072			5 53.656			5 48.377			5 50.307		
⚥	a	20.411	40.088	a	21.431	40.282	a	19.282	40.683	a	18.726	38.002
	1 20.411			1 21.431			1 19.282			1 18.726		
	b	02.422	04.757	b	02.677	05.032	b	00.678	01.431	b	03.477	07.056
	2 22.833			2 24.108			2 19.960			2 22.203		
	c	17.288	33.955	c	17.900	33.645	c	17.893	37.752	c	14.929	30.296
	3 40.121			3 42.008			3 37.853			3 37.132		
	d	(02.082)	(04.089)	d	(02.293)	(04.310)	d	(03.099)	(06.539)	d	(00.290)	(00.589)
	4 38.039			4 39.715			4 34.754			4 36.842		
	e	12.876	25.289	e	13.487	25.351	e	12.642	26.673	e	12.435	25.235
	5 50.915			5 53.202			5 47.396			5 43.277		

EXPLANATION OF TABLES 1 & 2. San Ysidro and Grants populations lend themselves well in introducing Tables 1 and 2, and describing their functions. To the left are sex symbols for male, female, and combined sexes. The black dot denotes the longer (a - e) expression for each character of the two chosen populations. If the dot is on the left (San Ysidro), the expression is longer than the Grants specimens on the right. But, if the dot is located on the right, that character is greater than the one on the left. San Ysidro males (a - e) have four characters, Grants exhibits one (c). San Ysidro females have only the dot, c, while Grants females possess four longer expressions. San Ysidro males and Grants females, placed opposite each other, produce a mirror image of each other. The crossed arrows indicate the "mirror image." The combined sexes alternate. Black triangles and white triangles denote the longest and shortest measurements respectively for the combined four populations to the left. San Ysidro and Grants combined populations receive 2 triangles: Willard and Kansas combined populations show 28 longest and shortest expressions.

In Tables 1 & 2, lower case letters a-e (see Fig. 1B) show the length of these characters which are used to compare one *fulgida* population with any other *fulgida* population.

As a means of presenting these data, I have developed a "new" method of presentation which I think more clearly shows the "mirror image" of certain characters when comparing these populations. This new method probably requires a brief explanation (page 181).

Cicindela fulgida williamlarsi, new subspecies, Fig. 2

Medium size, fairly robust, dorsal color a rich burnt-copper red.

Head: Head setose though not diagnostic for the subspecies level; vertex with interocular striae pronounced longitudinally between and behind eyes, flanked laterally by gold-orange or partially green lines; angles of eyes and epicranium metallic purple, extending posteriorly to occiput. Genae blue-green, turning green posteriorly. Labrum length 50% of width, imperfectly tridentate; mandibles strongly sexually dimorphic. Antennal segments 1-2 all green in color, segments three and four red and bronze above, green below.

Thorax: Thorax slightly narrower than eyes at widest point, then narrowing posteriorly; disc color burnt-copper red; anterior and posterior impressions fairly deep, median impression shallow, finer impressions radiate away from deep impressions.

Elytron: Elytron elevated anteriorly between suture and humeral lunule; ground color including suture metallic-burnt-copper red; maculations whitish-tan. Humeral lunule narrower at shoulder, the inner notch borad (= maculation width narrow) reaching to edge of shoulder, then expanding posteriorly towards suture. Middle band very wide at margin (70.6%), but narrows, extending towards suture, not expanding at "knee" 77.7%, then turning parallel to suture, terminating in an oval "foot." In the sample of 72 specimens measured, 11 specimens were fused between humeral lunule and mid-band, at knee. Apical lunule, (see Fig. 2) begins at suture, extends laterally along posterior margin, then anteriorly forming a laterally concave terminus, 67.4%.

Ventral Surface: The pro-, meso- and metepisterna light green with yellow or golden tints, abdominal color shifting to blue-green posteriorly. Legs green anteriorly, with red tinges on tibia and tarsus when seen from a posterior view. Setal placement is not diagnostic.

Dimensions: Fairly uniform in size, 23 males average 11.46mm x 4.58mm; longest male 12.42mm; shortest male 10.42mm; 25 females average 11.68mm x 4.75mm, the longest 12.85 and the shortest 10.70mm.

Summary of Diagnostic Characters: Dorsal ground color burnt-copper red; maculations whitist tan; humeral lunule very narrow at shoulder; middle band very wide at margin 70.6%, narrow 29.4%; 22.3% of male San Ysidro specimens widened at knee, 77.7% not expanded at knee. Referring at Tables 1 & 2, San Ysidro males have humeral lunule (a) longer than Grants and Willard specimens; gap between tip of humeral lunule and mid-band (b) longer than Grants; length of descending mid-band (c) shorter than Grants; overlap of mid-band and apical lunule (d) longer than Grants; apical lunule (e) longer than Grants, but shorter than Willard specimens. In San Ysidro females (a) humeral lunule shorter than both Grants and Willard populations; gap (b) between tip of humeral lunule and mid-band shorter than Grants; length (c) of descending mid-band longer than Grants specimens; overlap (d) of mid-band and apical lunule shorter than Grants; apical lunule shorter than Grants specimens. Male and females combined exhibit a humeral lunule (a) shorter than Grants; gap between tip of humeral lunule and mid-band (b) shorter than Grants; length of descending mid-band (c) longer than Grants; overlap of mid-band and apical lunule shorter than Grants, apical lunule shorter than Grants specimens.

Type Locality: San Ysidro, Sandoval Co., NM; specimens found on salt marshes and alkaline soil that flank Rio Salado River, then joining the larger north-south drainage, the

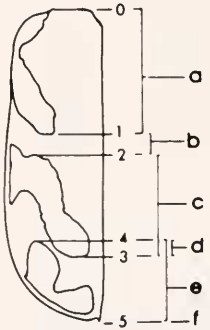


FIG. 1B

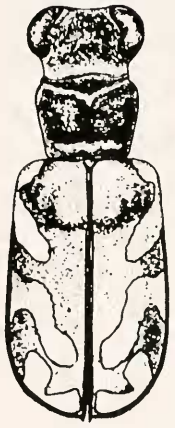


FIG. 2

FIG. 3

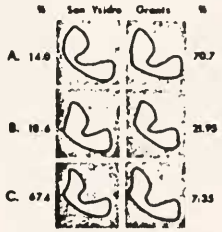


FIG. 4

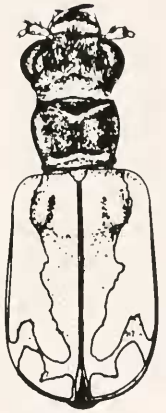


FIG. 5

FIG. 6

Fig. 1B. Method of measuring maculations, gaps, and overlaps. Fig. 2. *Cicindela fulgida williamlarsi,* n. ssp. Fig. 3. *C.f. winonae,* n. ssp. Fig. 4. Comparison of percentage of incurved, straight, and outcurved apical lunule maculations of the San Ysidro and Grants populations. Fig. 5. *C.f. rumppi,* n. ssp. Fig. 6. Typical elytra markings of nominate *C.f. fulgida* and *C.f. westbournei* (eastern or Great Plains component).

Jemez River; Mont Cazier, VI-26-1948; Norman L. Rumpp; VI-12-55, X-10-1975, IX-27-80; Walter N. Johnson, V-24-1983, collectors.

Etymology: This *fulgida* subspecies is named for my son, William Lars, who is ten at this writing.

Type Series: Holotype male, and 20 paratypes to Norman L. Rumpp. Allotype female collected by N.L. Rumpp, and 4 paratypes to the Calif. Acad. Sci.; 4 each to L.A. Co. Mus., U.S.N.M., 6 to R.L. Huber, 6 to D.L. Pearson; 4 to Walter N. Johnson, plus 19 returned to him; 4 to Howard P. Boyd; the remaining are in the author's collection.

Discussion: The San Ysidro population at first glance appears to be similar to the Grants population, with the exception of colors. However, upon closer examination, they are uniquely different, as the alternating measurements show in Tables 1 & 2.

Cicindela fulgida winonae, new subspecies. Fig. 3.

Medium in size; robust; dorsal color metallic red, dark wine, burnt copper, bright green, dull green, dark blue, dark purple, or dark brown; elytral maculations narrow, rarely fused.

Head: Head setose, though not diagnostic at subspecies level; interocular striae pronounced longitudinally between and behind eyes. Frons with many setae. Head color metallic red, dark wine, burnt copper, bright green, dull green, dark blue, dark purple, or dark brown. Great variety of head colors occur inconsistently, but the pattern of colors remains true. Labrum length 50% of width, imperfectly tridentate; mandibles sexually dimorphic. Antennal segments 1-4 metallic in color, but inconsistent as to location of color.

Thorax: Thorax slightly narrower than eyes at widest point, then narrowing posteriorly. Disc colors usually same as head. Lateral impressions fairly deep, usually green in color. Median impression shallow with finer impressions extending laterally.

Elytron: Elytron expanded between suture and humeral lunule; ground color brown or red metallic 86%, blue or green 14%, often with a narrow green margin; suture bright metallic wine-red; maculations tan in color. Humeral lunule weakly expanded at margin, inner notch usually broad (= maculation width narrow), reaching edge of shoulders, then expanding and extending posteriorly towards suture. Middle band narrow at lateral margin 53.8%; 46.2% wide; middle band widens anteriorly at turn, rarely fusing with humeral lunule, posterior extension angles toward suture, forming an oval terminus; apical lunule begins at suture, extends laterally along posterior margin, turns up and inward toward suture 70.7%, straight, (the reverse of San Ysidro) Fig. 4.

Ventral Surface: Pro- and metepisterna usually light green, mesepisterna vary in color; legs green dorsally and ventrally. White hairs numerous on thorax and legs. Setal placement is not diagnostic.

Dimensions: Average male length 12.00mm x 4.56mm; longest male 12.42mm; shortest male 10.70mm. Female: average 12.49mm x 4.47mm; longest female 13.28mm; shortest female 11.28mm.

Summary of Diagnostic Characters: Ground color expressed in many metallic colors dorsally; maculations whitish tan; humeral lunule narrow below shoulder; middle band usually narrow at margin, and very narrow from bend to terminus; apical lunule moves laterally, turns forward toward suture. Referring to Tables 1 & 2, male humeral lunule (a) shorter than San Ysidro (S.Y.); gap between tip of humeral lunule (b) and mid-band shorter than S.Y.; length of descending mid-band (c) longer than S.Y.; overlap of mid-band and apical lunule (d) shorter than S.Y.; apical lunule (e) shorter than San Ysidro and Willard specimens; Grants female humeral lunule (a) intermediate of the three N.M. subspecies; gap between tip of humeral

lunule and mid-band(b) longer than S.Y.; length of descending mid-band(c) shorter than S.Y.; overlap of mid-band and apical lunule (d) longer than S.Y.; apical lunule (e) longer than S.Y. Grants combined male-female measurements (a) longer than S.Y.; gap between tip of the humeral lunule and mid-band (b) longer than S.Y.; length of descending mid-band (c) shorter than S.Y.; overlap of mid-band and apical lunule (d) longer than S.Y.; apical lunule longer than S.Y. specimens.

Type Locality: Grants, Valencia Co., N.M., along the Rio San Jose, on salt marshes, and in the town (according to Rumpp, private conversation).

Type Series: Holotype male and 43 paratypes to Norman Rumpp. Allotype female and six paratypes to the Cal. Acad. Sci., 4 to the A.M.N.H., 4 to L.A. Co. Mus., 30 to J.A. Shetterly, 19 to Walter N. Johnson, and 6 to the author's collection.

Etymology: This rainbow-hued subspecies is named for my wife, Winona.

Discussion: The Grants population appears in many dorsal colors, which is unique in itself. The mid-band is narrow where it enters at the margin, while San Ysidro specimens are expanded laterally; the knee swells anterio-medially. The apical lunule turns inward, in contrast to the San Ysidro population.

Cicindela fulgida rumppi, new subspecies. Fig. 5.

Medium to small in size; head and thorax metallic red-copper or bronze with green; elytral maculations usually confluent and expanded; smallest of the New Mexico *fulgida* subspecies.

Head: Head setose, though not diagnostic for subspecies level, interocular striae pronounced longitudinally between and behind eyes. Frons with numerous setae. Head color metallic copper-red extending posteriorly to pronotum; forward medially to clypeus, and laterally to inner angle of eyes, separated by lines of green from anterior corners of eyes to vertex. Gena greenish at mandible, shifting to blue at pronotum. Labrum length 50% of width, imperfectly tridentate; mandibles strongly sexually dimorphic (for all *fulgida* specimens examined), maculation on left mandible extends to mid-base of distal tooth of males, to middle tooth only in females. Antennal segments 1-4 metallic-green above and below, coppery near distal end of segments 3 and 4.

Thorax: Thorax slightly narrower than eyes at widest point, then narrowing posteriorly. Disc copper, impressions fairly deep, median impression shallow, finer impressions extend laterally to sides. Transverse sutures green, occasionally blue.

Elytron: Moderately expanded between anterior part of suture and humeral lunule. Ground color burnt copper-red; maculations tan. Markings very wide, occupying up to 50% of the surface area. Initial study population consisted of ninety Willard specimens. Twelve specimens (13%) are confluent for humeral, mid-band, and apical lunule; 59 (65.5%) have humeral lunule fused with mid-band; and 19 (21%) are non-confluent. Inner margin of humeral lunule not broken by a small notch for 64% of population; 36% broken by small notch; terminal portion broad. Mid-band extremely wide at lateral margin, with a very wide extension towards suture, then descending, and terminating in a broad oval turned towards suture. Apical lunule massive, angular, with a "V"-notched anteriorly.

Ventral Surface: Color metallic blue or green laterally, dark blue to purple in mid-surface. White hairs numerous on thorax and legs; white hairs dense on abdominal surfaces: setal placement of no taxonomic importance.

Dimensions: Average male length 10.30mm x 4.42mm; longest male 11.56mm; shortest male 9.28mm. Female: average 10.49mm x 4.47mm; longest 11.42mm, shortest 10.14mm.

Summary of Diagnostic Characters: Longest elytral maculations relative to elytral length except male humeral lunule, which is shortest of three N.M. populations; unique maculation configuration; high percentage of maculation fusion.

Type Locality: New Mexico, Torrance Co., 7.2 mi. E. of Willard, Laguna del Perro; only locality known. The habitat of *C. fulgida* consisted of an alkaline crust, often elevated on vegetation so that cicindelids could hide underneath. The wide maculations against the white sand crust makes detection difficult.

Etymology: This subspecies is named for Norman L. Rumpp, whose studies have advanced our knowledge of the Cicindelidae in the west by including in his studies geology, uplifting, paleoclimate and migration routes.

Type Series: Holotype male and 31 paratypes to Norman L. Rumpp. The allotype female, and 5 paratypes to the Calif. Acad. Sci.; remaining paratypes: 4 each to L.A. Co. Mus., A.M.N.H.; 30 returned to J.A. Shetterly, 22 returned to Walter N. Johnson, 3 to R. Huber, 4 to D. Pearson, and 14 in the author's collection.

Discussion: Willard specimens are uniformly smaller in body size, yet elytral maculations are longer relative to body size. It is suggested that maculations genetically remained constant in size, while natural selection favored a reduced body size. Therefore, the relatively longer maculation surface-area should (1) reflect relatively more light (thus reducing heat absorption), and (2) render them less visible to predators when seen against the salt crust. Willis (1967) concluded (p. 264-65) that the Willard sample he examined was the only clear grouping that could be called a subspecies, based upon his computer analysis. He interpreted this, however, as an artifact caused by lack of comparative material from South Dakota, Wyoming and Montana.

Key to the Subspecies of ***Cicindela fulgida***

1a. Middle band right-angled, with descending portion essentially parallel to the elytral suture. . . . 2

1b. Middle band obtuse-angled, with descending portion angled towards the elytral suture. . . . 3

2a. Larger (avg elytral length of males 6.92mm or greater); bright metallic red in autumn & early spring, turning darker red in mid-summer (Lincoln, Nebraska population may have 40% black morphs); central Great Plains north to se Alberta, sw Saskatchewan, s/sw North Dakota . . . . *fulgida*

2b. Smaller (avg elytral length of males 6.91mm or less); dark, greasy red-violet (80%) with occasional bright blue or green (20% or less) individuals (Manitoba, nc North Dakota, nw Minnesota. . . . *westbournei*

3a. Middle band not expanded at margin, and often slightly narrowed there (Fig. 3). . . . . *winonae*

3b. Middle band expanded at elytral margin 4

4a. Middle band moderately expanded at margin, but not approaching contact with humeral lunule along margin (Fig. 2) . . . . *williamlarsi*

4b. Middle band broadly expanded along elytral margin, usually approaching humeral lunule (and often connected to it along elytral margin. 5

5a. Avg elytral length of males 12.1mm, females 12.6mm maculation broad (s Wyoming) . . . . *pseudowillistoni*

5b. Avg elytral length of males 10.8mm, females 11.2mm maculation broader to confluent (c New Mexico) (Fig. 5) . . . . *rumppi*

SUMMARY

C. fulgida can be clearly divided into two "major" components. The eastern or Great Plains component is characterized by having the descending portion of the middle band parallel to the elytral suture (Figs. 1Ab and 6) and includes the nominate race and *C. fulgida westbournei.* The western or montane component is characterized by having the descending portion of the middle band angled towards the elytral suture, (Fig. 1Aa) and includes *C.f. pseudowillistoni, C.f. williamlarsi, C.f. winonae,* and *C.f. rumppi.* The population from southern Colorado currently under study by the Reverend Bernard Rotger will probably also fall within this component. It is noteworthy that Gaumer (1977) has similarly found that *C. formosa* Say has major eastern and western components which he then subdivides further into more localized geographic races. Perhaps this phenomenon extends to other Nearctic species as well.

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LITERATURE CITED

Calder, E.E. 1922a. New Cicindelas of the *fulgida* group (Coleop.) Can. Ent. 56: 62.

Calder, E.E. 1922b. Change of names in *Cicindela.* Can. Ent. 54: 191.

Ferris, C.D. 1969. Notes on collecting early *Cicindela* in eastern Wyoming. Cicindela 1(2): 10.

Gaumer, G.C. 1977. The variation and taxonomy of *Cicindela formosa* Say (Coleoptera: Cicindelidae). Ph.D. Thesis, Texas A&M Univ. College Station, Texas. 253 pp.

Horn, W. 1938. 2000 Zeichnungen von Cicindelindae. Entomologische Beihefte, Berlin-Dahlem 5: 13.

Rumpp, N.L. 1961. Three new tiger beetles of the genus *Cicindela* from southwestern United States. Bull. So. Calif. Acad. Sci. 60(3): 165-187.

Rumpp, N.L. 1979. North American tiger beetles of the genus *Cicindela:* the role of male genitalia in systematics and phylogeny. (unpublished study).

Say, T. 1823. Descriptions of coleopterous insects collected in the expedition to the Rocky Mountains. Journ. Phila. Acad. Nat. Sci. 3: 139-216.

Wallis, J.B. 1961. The Cicindelidae of Canada. Univ. Toronto Press. 74 pp.

Willis, H.L. 1967. Bionomics and zoogeography of tiger beetles of saline habitats in the central United States (Coleoptera: Cicindelidae). Univ. Kansas. Sci. Bull. 47(5): 145-313.